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ABSTRACT

The major objective of this conference was the continuation of the exchange of information on the improvement of pre-service and inservice methods courses and other program offerings in mathematics education. Topics highlighted included the effects of state mandated programs for teacher preparation, the growing shortage of qualified mathematics teachers to meet the needs of schools, and the various components of methods courses for elementary and secondary mathematics teachers. These proceedings contain: an introduction to the material, a summary of the opening session, two invited addresses, summaries of fifteen discussion sections, and an alphabetized list of conference participants and addresses. The invited address by Tom Cooney is entitled "Do Research and Teacher Education Have An Intersection": the second address, by Perry Lanier, was entitled "Participant Observation: A Method of Inquiry in Mathematics Education." (MP)

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PROCEEDINGS OF THE SECOND MATHEMATICS METHODS CONFERENCE: A SUMMARY

Edited By

John A. Dossey

Illinois State University

June 11-13, 1980

Illinois State University
Normal, Illinois

Sponsored By

Mathematics Department, Illinois State University
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Contents

Table of Contents..... 1.

Introduction..... 3.

Opening Session..... 6.

Do Research and Teacher Education Have An Intersection?..... 9.
(Invited Address: Tom Cooney, University of Georgia)

Participant Observation: A Method of Inquiry in Mathematics Education (Invited Address: Perry Lanier, Michigan State University).....19.

Discussion Sections

Instructional Strategies for Basic Facts Teaching.....34.

Clinical Experiences for Pre-Service Elementary Majors.....36.

Using the Hand Calculator in Methods Class.....39.

Recruiting Secondary Mathematics Majors.....41.

Teaching Algorithmic Processes in Elementary Methods.....43.

Testing Mathematical Competencies of Elementary Teachers.....45.

Simulations and Their Role in Secondary Methods.....46.

Using Textbooks and other Instructional Aids in the Elementary Methods Course.....48.

Establishing and Managing a Mathematics Clinic .....50.

Arranging and Monitoring Clinical Experiences for Pre-Service Secondary Teachers.....54.

Diagnostic and Prescriptive Mathematics for Secondary Majors: Pre-Service and Inservice.....55.

Structuring Methods classes to Meet a Wide Variety of Student Needs and Backgrounds.....56.

The Role of Laboratory Experiences in Pre-Service Methods Classes.....58.

Inservice Mathematics Education Programs.....60.

Diagnostic and Prescriptive Mathematics for Pre-Service and Inservice Elementary Majors.....62.

Participants and Addresses.....64.

INTRODUCTION

The Second Mathematics Methods Conference was held at Illinois State University on June 11-13, 1980. Building on the successful conference held at the University of Northern Iowa in 1978, the Second Mathematics Methods Conference continued the focus on problems and issues confronting collegiate mathematics educators in the preparation of pre-service teachers and the assisting of in-service teachers.

The major objective for the conference was the continuation of the exchange of information on the improvement of methods and other program offerings in mathematics education. Topics highlighted in these exchanges and in the program were the effects of state mandated programs for teacher preparation and the growing shortage of qualified mathematics teachers to meet the needs of schools. Other topics of special interest were the various components of the special methods courses for elementary and secondary mathematics teachers.

The program for the conference was divided into three different types of activities. The first, held on Wednesday evening, was a series of short reports on special programs or projects of note currently underway at six of the schools represented. The second group of activities consisted of sixteen discussion sections on fixed topics. Each of these was formed around a short presentation by a discussion leader followed by open discussion. The third program form was a pair of invited addresses. Dr. Thomas Cooney of the University of Georgia spoke on the use of research findings in the mathematics methods class and the training of pre-service teachers. Dr. Perry Lanier of Michigan State University spoke on observations and their role in the training of teachers.

Brief reviews of the Wednesday evening presentations and summaries of the discussion groups follow, along with the texts of the two invited addresses.

The success of the conference was directly due to the input of each of the participants through their contributions in the various discussion groups and in the informal exchanges accompanying them. In addition, several of the participants served in the capacity of presenters, discussion group leaders, or recorders. Without their assistance the conference would have been impossible.

Central States Universities, Incorporated, provided support for the two invited talks through a travel grant. The Provost's Office at ISU provided assistance in the form of facilities arrangements and a reception for the conference participants following the opening session. Dr. Albert Otto, Chairman of the Mathematics Department at ISU, provided several forms of departmental support, including the excellent services of a most capable student assistant, Laurie Romersberger. Among the efforts expended by the ISU faculty, the efforts of Lynn Brown, Sharon Priester, and Barbara Wilmot deserve special thanks.

The conference evaluations also reflect the satisfaction of the participants with the outcomes. While several comments for format improvement and additional topics were received, the overall response indicated a feeling of personal and professional growth resulted from the meeting. Special mention was made of the opportunities for informal exchanges among those people in attendance. To assist in the continuation of these exchanges, a complete address list is found at the end of these proceedings.

It is hoped that the many ideas discussed have found their ways into the improvement of the programs in mathematics education at the 30 schools represented. If so, the conference has met its basic objective.

OPENING SESSION

The conference began on Wednesday evening with a welcoming statement from the Chairman of the Illinois State University Department of Mathematics, Dr. Albert Otto. He welcomed the participants to the campus, relating the long heritage of the university in the education of teachers of mathematics at all levels. He stressed the growing importance of the pressures being placed on mathematics educators through the "Basic Skills" movement and the growing shortage of qualified teachers of mathematics. At the same time, he noted the opportunities for change and growth as outlined in NCTM's An Agenda for Action.

Dr. Phares O'Daffer of Illinois State University then described the origin and uses of the Elementary Mathematics Laboratory in the Mathematics Department. He presented an overview of the types of materials available, the uses made of them both in and out of the laboratory, and several of the administrative problems associated with such a venture. He closed by sharing two laboratory activities from the laboratory with the participants: a mathematics textbook series scavenger hunt and a form for pre-service teachers to use in the evaluation of manipulative materials for mathematics classes.

Dr. Thomas O'Brien of Southern Illinois University at Edwardsville then provided an introduction to their Teachers' Center Project. He described the ongoing in-service activities focused at three teacher center locations in the St. Louis metropolitan area. Through university and external support, the program has been able to staff the weekly sessions at the centers with staff and visiting mathematics educators. These sessions are free to the teachers participating and build around

the themes of child development and mathematics learning. These sessions have resulted in a large number of collaborative efforts of the faculty from the university and the public schools. These efforts have resulted in a large number of classroom activity material packets, research studies, and monographs for teachers.

Dr. Bernadette Perham of Ball State University then gave an overview of their new teaching program designed for junior high/middle school mathematics teachers. This program, designed to satisfy the requirements of the Indiana Standard License in Junior High/Middle School Education, has the following quarter hour course requirements:

Math 161 Applied Calculus I (4 hrs.)
Math 162 Applied Calculus II (5 hrs.)
Math 201 Cardinal Numbers in the Elementary School (3 hrs.)
Math 202 Rational Numbers in the Elementary School (3 hrs.)
Math 203 Real Numbers in the Elementary School (3 hrs.)
Math 204 Geometry in the Elementary School (3 hrs.)
Math 211 Structure of the Number Systems (5 hrs.)
Math 221 Applied Probability and Statistics (4 hrs.)
Math 240 Introduction to the Teaching of Geometry (4 hrs.)
Math 309 Computer and Enrichment Topics for the Junior High/Middle School Teacher of Mathematics (3 hrs.)
Math 393 The Teaching of Mathematics in the Junior High/ Middle School (4 hrs.)

In addition, she described the processes by which an elementary teacher or secondary teacher could add on to their certification program in order to get the junior high/middle school endorsement from the state office.

Dr. Katherine Pedersen of Southern Illinois University at Carbondale shared their concept of "shadow courses" with the participants. These courses, serving as adjuncts to the required courses in algebra and analysis for secondary majors, are designed to provide the students with additional examples and applications, as well as an introduction to the teaching of mathematics. This latter activity involves the students in the reading, development and organization, and teaching of the material

to their peers in the "shadow courses." This set of activities helps prepare the students both mathematically and as prospective teachers. It gives a good screening for potential student teaching problems, while at the same time teaching students how to learn and then teach new topics in mathematics.

The metric project for teachers at Indiana State University was then described by Dr. Walt Sanders. He related the scope, sequence, and activities involved in preparing teachers to deal with the concepts and related activities in the metric curriculum. Special emphasis is placed on the development of estimation and activity oriented activities. In addition, he provided a nice overview of the sessions at the recent national metric conference he had just returned from in San Francisco.

The opening session closed with Dr. Jane Swafford's report on the NSF funded Geometry Project for Teachers she directs at Northern Michigan University. She related the origin of the project stemming from the problems of in-service work in the upper peninsula of Michigan. These problems are especially compounded by low population density, the resulting long distances, and the weather. To counter these problems, the project was designed to provide evening in-service in collector communities with the instructor staying overnight to work in one of the participant's schools on the following day. To date, the project had been most successful in meeting the in-service needs and getting the materials and activities into the school's classrooms.

Following these presentations, the session adjourned to the university's art gallery for a reception provided by the Provost's Office. This reception provided the vehicle for continuation of these presentations on an individual level.

DO RESEARCH AND TEACHER EDUCATION HAVE AN INTERSECTION?

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It is a pleasure to have the opportunity at a conference such as this to share, discuss, and debate a central aspect of our profession--educating mathematics teachers. There are issues which are critical to our profession and which cry for attention and consideration. I welcome, indeed savor, the invitation to be a part of that discussion. My enthusiasm is tempered somewhat by an apprehension created by a recognition of our common problems and an awareness of how little we know to resolve those problems. Please bear with me as I try to convey how at least one individual struggles with the problems of mathematics teacher education.

Research and Mathematics Teacher Education--A Hiatus

Most of us expend considerable time and energy in our efforts to education preservice and inservice mathematics teacher. But I'm afraid we have not expended much energy in communicating our efforts and reflections and insights on these efforts to our colleagues. In terms of research, I submit that there exists a considerable imbalance between our efforts to study how students learn mathematics and our efforts to learn how the students' teachers learn to teach mathematics. In short, there appears to be a dearth of information related to the processes of teacher education. To support this assertion, I offer the following

evidence.

From the NACOME Report (1975) we have the statement:

> The dominant feature of the mathematics teacher education picture is the absence of hard data concerning programs and practices, requirements, and characteristics of the products. Much of what is written, discussed in conferences, and used to justify recommended programs is based on sketchy impressionistic data, random cases of innovative activity and research and opinion. In is impossible to even attempt a description of the "typical" graduate of a teacher education pre-service program, much less that same individual after possible exposure to a wide variety of in-service training experiences. (p. 81)

The editor of The Mathematics Teacher inserted a note after an article on teacher education (Aviv and Cooney, 1979) encouraging the submission of other articles on teacher education. At the Third International Congress in Mathematics Education, Otte (1976) underscored the lack of research in mathematics teacher education and characterized teacher education as basically reactionary to whatever school reform exists at a given point in time. Hence, according to Otte, teacher education is moved by forces better characterized as whimsical rather than rational.

Despite this evidence, I do feel that teacher education is becoming an increasingly more important object of serious reflection. Certainly this conference speaks well for such interest.

Research on Teacher Education - State of the Art

One of the central issues with which we have to contend is the question of whether there exists a body of pedagogical knowledge deemed important enough to warrant its inclusion in mathematics teacher education. The issue is not trivial. Popham (1971) investigated the performance of experienced, certified teachers with the performance of individuals who were not trained or who indicated no prior teaching experience. Popham concluded that "experienced teachers are not particularly skilled at bringing about prescribed behavior changes in learners" (p. 115). Some might be inclined to dismiss the study since it did not involve the teaching of mathematics and the instructional time (only four hours) was short. Still the nagging question remains "Do those trained in the teaching of mathematics outperform those not so trained?" At present we cannot be assured the answer is affirmative.

Nevertheless, I am going to assume, hopefully with some justification, that a sufficient body of pedagogical knowledge does exist to permit a serious study of the processes of mathematics teacher education. Permit me to briefly mention a few studies on teacher education. (For a more comprehensive review, see Cooney (1980).)

Peck and Tucker (1973) conducted an extensive review of research on teacher education (not necessarily on mathematics teacher education). One of their conclusions was that a "systems" approach to teacher education substantially improves a program's effectiveness. Such an approach requires that (a) desired learning behaviors be precisely

defined, (b) training procedures be planned to meet the objectives, and (c) attainment of the objectives be measured, followed by feedback to the teacher and a possible recycling of the entire process. The weight of the evidence is that teachers who are trained to specify objectives and then to teach to those objectives are more effective. Peck and Tucker also found evidence that teachers can be taught to adopt certain teaching techniques or behaviors, at least in controlled situations, when given practice in that behavior and feedback on their progress in acquiring it. Another finding cited by the authors was that pre-service interns tended to become more bureaucratic, authoritarian, and less humanistic in their teaching as they progressed through their student teaching program. Turner's review (1975) of research on teacher education supported Peck and Tucker's findings. Turner also found microteaching and viewing films were effective means of training teachers to acquire desired behaviors.

Many studies on teacher education have applied a method A vs. method B paradigm to research problems. This approach has borne some fruit and yielded useful information as suggested by the reviews cited above. But care must be taken that simplistic paradigms do not establish an "engineering mentality" approach to conceptualizing teacher education. Training teachers is too complex to be totally subjected to a component analysis in which each component becomes an entity to be trained.

One of the problems, as I see it, is that the effectiveness of various methods of teaching pedgogical knowledge have not been studied

in light of the type of content being taught. A variety of techniques for training teachers is available, including the following.

I. Classroom activities
   Lecture/discussion
   Using media materials, e.g., video tapes
   Role playing

II. Laboratory activities
   Tutoring
   Microteaching
   Clinical interviews with students

III. Field activities
   Small-group instruction
   Large-group instruction

But there are different types of content also. In our methods text (Cooney, Davis, and Henderson, 1975) different types of mathematical content were identified: concepts, generalizations, and skills. Such a classification scheme also has some merit in classifying pedagogical content. Consider the classification below:

	Mathematical Content	Pedagogical Content
Concepts	Function Prime number	Clarity of a presentation Heuristic teaching methods
Generalizations	The Pythagorean theorem The law of sines	Law of reinforcement Various maxims for teaching by discovery
Skills	Factoring trinomials Solving equations	Diagnosing learning problems Questioning students

Although a more thorough analysis might be productive, the classification given above permits a few questions to be posed. Which of the types of teaching techniques are best for the various types of content? It may be, for example, that trying to help an intern acquire competence in the use of counterexamples can best be accomplished by

lecture/discussions or viewing video tapes. Field activities may be inefficient. How can an intern acquire the concepts of heuristics for teaching problems? Perhaps heuristics can be taught in the same way mathematical concepts are taught--through the use of examples, non-examples, and illustrations of their utility. For what type of content are field activities appropriate? Certainly they are imperative for utilizing and practicing whatever pedagogical knowledge is acquired. In a sense, teaching is a skill (or perhaps better said, a skilled art) and skills can only be developed by practice. For the intern, that means practice in the field, teaching and working with students.

Bridging the Gap Between Research and Mathematics Teacher Education

Research seems to indicate that teachers can be trained to adopt certain teaching techniques. The exact techniques which are consistently associated with student achievement have not been completely explicated to be sure, but we are learning. But our methods and, indeed, our questions related to research on teacher education require serious examination. As mentioned earlier, research on how children learn mathematics is far more extensive and sophisticated than its counterpart on how children's teachers learn to teach mathematics. Consider for the moment the questions below which reflect the research agenda of many mathematics education researchers. (My apologies to those who have a different agenda.)

1. What mathematical structures do students bring to the learning enterprise?
2. How can instruction be designed to take advantage of students' natural thought processes?
3. How do students process information when studying mathematics?

These same questions, I submit, are applicable to research on teacher education. Consider the following questions.

1. What conceptions of mathematics and of the teaching of mathematics do teachers have?

2. How can teacher education programs be designed to take advantage of those conceptions and the way in which teachers conceive of their roles (or expected roles)?

3. How does the teacher process pedagogical knowledge? What cues are attended to when instructional decisions are made?

These questions suggest a global view of teaching and teacher education. The latter three highlight those processes by which teachers internalize knowledge about teaching. They reflect the heart of the process of teacher education and ought to be the focus of our attention.

While each of us has our own agenda of content to teach, we can nevertheless pose some common questions. Do our interns see mathematics from a "dichotomous" viewpoint, that is, as a subject with the right or wrong methods of solving problems? To what extent do interns' conceptions of mathematics envision a dynamic subject, one which consists of multiple approaches and where the answers are contingent upon the assumptions underlying the problem? When interns study pedagogical knowledge, how is that knowledge used? Can the interns use it to generate ideas for instruction or is their behavior imitative? Can they use the knowledge to describe and reflect upon their behavior? The pursuit of answers to these and related questions can enrich our understanding about how interns acquire and utilize the knowledge we desire them to learn.

In working with pre- and in-service teachers I am often struck by

the differences across teachers in their receptivity to ideas about teaching. The continuum consists of the end points "I could use that idea" to "Nothing works in my class" with "points" in between. Rokeach offers a definition of what he terms the "open mind" and the "closed mind." At the risk of oversimplifying his conceptions, the following brief summary is offered.

> The open person tends to envision shades of gray between dichotomous positions. The closed person does not.
>
> The open person tends to view the world as a friendly place. The closed person views it as a threatening world.
>
> The closed person tends to think of authority as absolute. The open person tends not to.
>
> The open person tends to differentiate information from the giver of the information. The closed person tends not to.
>
> The open person is better able to receive, evaluate, and act on relevant information received from the outside on its own intrinsic merits, unencumbered by irrelevant factors in the situation arising from within the person or from the outside.

Perhaps such a conceptualization has merit for our work. Intuitively, it would seem that an "open" teacher would be the better recipient of pedagogical knowledge.

The question of whether "openness" or "closedness" is a static or dynamic trait can also be raised. If dynamic, what sets of activities tend to influence the degree of openness of a teacher? Is it the case that the open teacher is really the better teacher--however "better" is defined? Does one type of teacher profit more from an "input" model of teacher education, that is, one in which the intern is told how to teach as opposed to an apprenticeship model or some derivative in which the primary mode of learning is experential in nature? In

short, is there some sort of an "aptitude-treatment-interaction" effect between the type of teacher and the model employed for a teacher education program?

These questions are only conjectures. I have no evidence to suggest what actually might be the case. But they may provide a basis for bridging the gap between research and mathematics teacher education. We might then have a more substantial intersection between research and a vital aspect of our professional activities.

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PARTICIPANT OBSERVATION: A METHOD OF INQUIRY IN MATHEMATICS EDUCATION

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OVERVIEW

Since 1978 my colleagues and I have engaged in participant observation studies in twelve junior high school mathematics classrooms. The classrooms of primary interest have been ninth grade general mathematics classes; but for comparative/contrastive purposes we have also looked in algebra classes, remedial classes, a combined seventh-eighth-ninth grade class, four eighth grade classes taught by the same teacher, and a ninth grade social studies class that included a number of students from an observed general mathematics class.

Our looking has been driven by the consensus among secondary mathematics teachers and mathematics chairpersons or supervisors that ninth grade general mathematics classes were unrewarding experiences for both teachers and students. Our research objectives have been to accurately and narratively portray life in general mathematics classrooms with an eye toward improvement, but to date the focus has been on capturing "what is" in contrast to "what can be."

In ascertaining what life for teachers and students is like in these classrooms we have used field research methodology. Basically, this is an adaptation and extension of ethnography--the method of the anthropologist--for purposes of studying educational settings. Field notes from classroom observations have been the primary data source,

but these have been augmented by teacher interview data, student artifacts such as tests and limited use of video-taping. The participant observers (data gatherers) have been teachers or mathematics educators trained to conduct field research and educational anthropologists. Our task as participant observers was to be as unobtrusive as possible, i.e., we made every effort to study the classroom in its natural state.

PRACTICAL INVESTIGATIONS IN MATHEMATICS CLASSROOMS

In 1970 Schwab stated, 'my own incomplete investigations convince me that we have not the faintest reliable knowledge of . . . what actually goes on in science classrooms."

Five years ago (1975) the National Advisory Committee on Mathematics Education (NACOME) of the Conference Board of the Mathematical Sciences reported, "The question, 'What goes on in the ordinary classroom in the United States?' is surely an important one, but attempting to survey the status of mathematical education at 'benchmark 1975', one is immediately confronted by the fact that a major gap in existing data occurs here. Appallingly little is known about teaching in any large fraction of U.S. classrooms."

This year (1980), a review of the 580 entries appearing in the tenth annual listing of research on mathematics education, published in the Journal for Research in Mathematics Education, by Suydam and Weaver, showed that twenty-five studies, slightly more than four percent, were conducted to address questions about classroom practices.

I content that the field of science education, in particular mathematics education, is in need of classroom research. I hope to show how such research can uniquely lead to the improvement of mathematics

teaching and mathematics teacher education as well as advancing the science education research field.

WHAT CLASSROOM RESEARCH?

The intent here is to portray a need for balance between research of the theoretic and research of the practical in the field of science education. Begle and Gibb (1980) cast the idea this way in a discussion of "New Direction" for research in mathematics education. "Research has developed competing explanations for partial views of learning . . . but generalizations from these partial theories are limited . . ., they are insufficient for the planning and realization of classroom practices. It is necessary to consider not only the student or the curriculum but also the general context of learning and the teacher's role in effecting learning." (p. 15)

Robert Davis (1977) attributed the following to David Hawkins: "One of the most important--and most neglected--aspects of science (is) the analysis and explication of practitioner knowledge." Davis continues: "Practitioners do know something, and a major stage in science occurs when the theorists study practitioner knowledge and try to relate it to theoretical modes of thought. This stage has been by-passed by education. Teaching is studied with the implicit assumption that teachers do not know what they are doing and theorists must come in and tell them."

The argument Davis makes for the need in completing the cycle of educational research activity rests primarily on the notion that without knowing what the practitioner knows we have only a partial picture. However, there is also an implicit point that seems to me to be of equal or greater significance: It is the notion of the practitioner as a <u>user</u>

of research. That is, being in possession of knowledge about practice may indeed make our science more complete, but for what purpose?

Is not one of the goals of research to inform and improve practice? Do we not know or suspect that teachers are influenced by other teachers more than any other variable? Does it not seem reasonable that research on classroom practices might appear more relevant (and thereby more likely) to be perused and used by teachers than the results of theoretic research?

Tom (1980), in an argument for a conception that portrays teaching as a "moral craft" rather than an "applied science" suggests both a need for and a use of research knowledge from the classroom. He observes:

> Despite the obvious differences in pedagogical knowledge and skill between the experienced teacher and the typical novice, the craftsperson teacher rarely attempts to pass systematically this accumulated wisdom to the next generation . . . teacher training programs contain little such codified knowledge and skills, and many professors . . . deny that such craft culture is valuable. Even experienced teachers often deny that their skills and knowledge . . . could be of value to other teachers . . . In other words, all teachers must discover, "what works for them individually"--of matching strategies and ideas to one's unique classroom of youngsters. The result of not receiving craft culture in preservice training--except perhaps in student teaching--and of believing that all teachers must develop a personal teaching style is the conception of teaching as an individualistic enterprise that must be learned by trial and error. (p. 320)

Given the case for classroom research; what do we want to find out? What do we want to become smarter about? Why? Schwab in the 1970 piece contends:

> What is wanted is a totally new and extensive pattern of <u>empirical</u> study of classroom action and reaction; a study, not as basis for theoretical concerns about the nature of teaching or learning process, but as a basis for beginning to know what we are doing, what we are not doing, and to what effect; what changes are needed, which needed changes can be instituted with what costs or economics, and how they can be effected with minimum tearing of the remaining fabric of educational effort. (p. 313)

Clearly Schwab is asking that we establish "what is" as objectively

as possible, then follow that assessment with evaluative judgments of "what should and could be." His point on "minimum tearing of the remaining fabric of educational effort" brings to mind the change strategy of Postman and Weingartner in their book, The Soft Revolution. Could Schwab have been saying to us that had we considered these things the curriculum reform movements of the Post-Sputnik era would have been implemented differently with different consequences. For example, had we thought in terms of a Soft Revolution versus A Revolution in School Mathematics what would we have needed to know? What would we have done differently? This information of conditions and their implications for change can only be validly obtained from serious and systematic investigation of classrooms. Furthermore, the implementation of any innovation is perilously endangered without such information.

In summary the need for classroom research appears to be twofold. First, a knowledge picture of teaching is incomplete without the classroom consideration. Second, the knowledge derived and communicated from classroom research is likely to have explicit and useful things to say to the practitioner (a phenomenon which may subsequently endear the teacher to research). Inherent in the twofold need for practical knowledge and its use are the questions that should be addressed in the context of the classroom--What's happening in the prelude to, during the flow of, and following instruction? What are the teacher's thoughts and actions relative to the classroom experience? What are the learner's thoughts and actions relative to the experience? How is the content of instruction enacted?

GENERAL MATHEMATICS CLASSROOMS: A STRATEGIC RESEARCH SITE

Ninth grade general mathematics as a research site emerged from three distinct, but nonsimultaneous events. The first of these events was the release, distribution and subsequent deliberations of the 1975 NACOME report. Though the report contained six chapters, two of them, "Patterns of Instruction" and "Teacher Education" were especially dissonance producing from many of us in mathematics education. It was in the "Patterns of Instruction" chapter that the jarring observation was made that appallingly little is know about what goes on in mathematics classrooms across the nation. The impact of the observations was intensified by reflecting on the level of effort exerted during the sixties on curriculum development and teacher development (though limited primarily to secondary education) and the level of effort (almost nil) exerted on ascertaining what happens to students in classrooms with these curricular materials and teachers. Having some achievement data on students in these classrooms provided little solace to such an obvious gap in our knowledge base.

The significance of the gap was further disquieting by the reports of teachers in the "Teacher Education" chapter that their most significant problems were those of dealing with motivation, laboratory learning, slow learners, learning styles of students, etc. "Lowest of the list are content topics." (p. 92)

The second influencing event leading to general mathematics as a research site was the creation, in 1976, by the National Institute of Education (NIE) of the Institute for Researching on Teaching (IRT) with Michigan State University's College of Education. The IRT focus was to be on the study of teacher thought, but teacher thought in terms of learner,

curriculum and setting. In 1977 the IRT sponsored an invitational conference to consider Research-on-Teaching Mathematics which resulted in a proceedings publication by that title (1977).

In addition to the mathematics conference the Institute also held a conference on Field Research Methodology in 1977. As a result of the two conferences I was prompted to take a sequence of seminars on field research. A practicum component in this training led me to observe in a general mathematics classroom taught by my colleague in mathematics education, Bruce Mitchell.

Bruce's presence in the general mathematics classroom is the third key event in the evolution of the General Mathematics Project. In a revision of the undergraduate secondary mathematics methods class, Bruce negotiated with a local school district to teach a geometry class on a daily year long basis. He wanted the students to have a weekly field experience in his classroom as part of the methods course. Over this year (1976-77) he discovered that the regular teachers, in their informal exchanges in the hall, lounge, etc., frequently expressed concerns about their respective general mathematics classes. For two reasons, his own enlightment and his methods students' enlightenment, he arranged to teach a ninth grade general mathematics class in the same high school during 1977-78. This was the site selected for satisfying the practicum requirement of my field research training.

During the course of the year two inquiries, prompted by my observations in Bruce's class, furthered the emergence of the general mathematics project. The first of these was a question of clarification to mathematics supervisor, Charles Zoet, who in a presentation at the annual University of Michigan mathematics education conference asserted that he and his

Livonia (Michigan) secondary teachers were not reaching half their students. His response revealed that these students were similar in many ways to those in Bruce's general mathematics class. Following this, I made an informal telephone poll of several mathematics supervisors across Michigan and found that at least half the students did take general mathematics. Furthermore, it was not only a class that generated disquietness and concern among the teachers but it was equally disquieting and disliked by the students.

Hence general mathematics was clearly problematic for students, teachers and supervisors. It was a problem that could only be significantly addressed by study of the problem where it existed--in the thought, actions and consequences of and for the teachers and students in the general mathematics classroom. It was indeed a setting worthy of study, a strategic research site.

PARTICIPANT OBSERVATION: A METHOD FOR CLASSROOM INQUIRY

The primary method used in the General Mathematics Project has been that of participant observation. Since it is virtually impossible for an adult to come across as an adolescent student in any naturalistic sense, our respective participant observers have had to establish themselves as a natural part of the scene. As a member of the scene our role was to participate as an observer.

Since the general mathematics classroom is, by reputation and consensus, exceedingly complex, the phenomenological approach seems most attuned to our proposed observation study. As Careini (1975) states, "The function of observing in phenomenological inquiry is to constitute

the multiple meanings of the phenomenon...." The task is therefore not to determine the single meaning of an event, but rather to reveal the multiplicity of meanings.

Given these theoretical underpinnings of participant observation studies, what are the domains where this method is most applicable?

Diesing (1971) subsumes a response to this question in his summary descriptive paragraph on the method.

> The participant-observer method was first developed by anthropologists, though it is also frequently used by sociologists, social psychologists, political scientists and organization theorists. Its primary subject matter is a single, self-maintaining social system. This system may be a small community with its own culture, or a larger society with its culture, or a small and relatively isolated neighborhood, or a gang, clique, voluntary organization, or family, or a formal organization or institution, or a person (clinical method), or a historical period. In each case the emphasis is on the individuality or uniqueness of the system, its wholeness or boundness and the ways it maintains its individuality. The primary objective is to describe the individual in its individuality, as system of rules, goals, values, techniques, defense of boundary-maintaining procedures and decision procedures. In one important variant, the primary interest is in recurring processes within or around such individual systems. (p. 5)

Diesing's description make the method extremely well fitted for attaining the objectives of the General Mathematics Project--identification and characterization of the manner in which the group identity, classroom organization and process, peer culture and teacher processes interact to influence mathematics learning both cognitively and affectively; and a focus on the contrasting perspectives of teachers and students on the meanings, events and purposes of these classes.

Participant observation seems particularly well suited as a method for the investigation of mathematics (science) classrooms, especially if the researcher's questions emanate from a practical problem. As an example, the two sets of questions we were concerned about in the NSF study, The Ecology of Failure in Ninth Grade General Mathematics: An

Ethnographic, Experimental and Psychometric Inquiry, were:

1. Who are the students who become the mathematically disadvantaged ninth grade population? What are their mathematics abilities, attitudes toward mathematics, learning histories and learning expectations? How do they wind up in general mathematics?

2. What effects do the two primary intructional environments--general mathematics or first-year algebra classes--have on the cognitive and affective mathematical development of early adolescents? How are those settings experienced by both teachers and learners, whose interactions define those learning environments and their consequences?

If these are representative of the questions that typically characterize a practical problem of the classroom, then the form of the answers to such questions becomes a concern. Clearly, the answers will not be in the form of statistical generalizations. They are rather more likely to be in the form of retrospective generalizations. According to Stenhouse (1978) retrospective generalizations are "organization(s) of experience in retrospect . . . are attempts to map the range of experience rather than to perceive within that range the operation of laws in the scientific sense."

Participant observation has its limitations. It cannot isolate student problems, i.e., learning deficiencies, misconceptions of mathematical knowledge, conceptual fragmentation, facility with computational skills, reading and reasoning abilities. It was only through intensive individual clinical interviews that we learned these things. For example, one student who hated math had spent three years in the second grade, another student exhibited fragmental math reasoning and memory ability while a third student displayed a remarkable misconception of fractions. Classroom observation also cannot answer the "whys" of teacher methodology. We observed one teacher in an algebra class constantly encouraging the students, expecting high levels of performance and patiently explaining

the rules and steps in solving problems. This same teacher in the general math class exhibited a lack of encouragement, low expectation of student achievement, no required homework and little direct instruction. A second teacher that was observed had a well run class that was exceedingly uneventful and boring. A third teacher varied in both verbal and physical exchanges with the students. Classroom observation captures the overt behavior of the students and teacher as they interact in this social setting. It does not account for the understanding of the behavior.

Participant observation seems appropriate for providing the researcher with a rich description of the learning environment. It describes curricular issues of the content covered, how it was presented and evaluated. It portrays the instructional flow of each observed session. These things are extremely useful to other teachers, teacher educators, teacher trainees as well as to administrators. Classroom observation seems likewise appropriate in examining the classroom social setting in looking at leaders, activists, rule followers, interaction between teacher and students as well as peer interactions.

Participant observation generates questions for those concerned with mathematical methods. One such question is, how does one change an observed practice of a teacher? Many other questions arise from the observed climate of the general mathematics classroom.

In summary, I have argued that participant observation, in the anthropological sense, is an appropriate method to use when investigating mathematics classrooms. I further contend that the questions asked and the answers suggested by analysis of the data will be in the form of retrospective generalization rather than predictive generalization, then expected form of answers to questions in a quantitative study.

PRELIMINARY FINDINGS FROM CLASSROOM RESEARCH

The following preliminary findings of our investigation are presented as an example of outcomes of classroom research where the primary method was participant observation.

1. Tracking, the policy commonly used for placing students within ninth grade math--whether into algebra or general mathematics--is usually highly correlated with students' record in mathematics classes during junior high school.

2. Teachers instruct general math classes differently than they instruct algebra classes. Further, these differences appear to be critical factors since they include aspects of teaching that are recognized as clearly related to student learning.

3. Most secondary mathematics teachers find it easier to think about, to plan for and to teach mathematically advanced classes than to do so for general math classes. Part of this imbalance stems from their difficulty in comprehending that students in general math can have serious problems in learning basic content.

4. Most teachers assigned to teach classes with a high percentage of youngsters identified as having low promise for successful achievement in mathematics (i.e., general math classes) have unusual difficulty in teaching these classes and often feel only marginally or not at all successful.

5. The low incidence of success and high incidance of frustration and failure encountered by both teachers and learners in general mathematics classes have created unique instructional settings that are notorious for their unpleasantness.

6. Though we know that most general mathematics students have a diversity of learning problems at a critical level, we do not know the precise nature of these problems.

7. Well established is the troublesome and problematic nature of teaching and learning general mathematics at the ninth grade level. Not well established are practices that alleviate the problems.

8. Overall, students placed in general mathematics classes appear to be different, in certain important ways, from students placed in algebra classes.

Given these preliminary findings let me conclude by returning to the quote of Schwab that I used in my argument for the need of classroom research:

> What is wanted is a totally new and extensive pattern of empirical study of classroom action and reaction; a study not as basis for theoretical concerns about the nature of the teaching or learning process, but as basis for beginning to know what we are doing, what we are not doing, and to what effect; what changes are needed, which needed changes can be instituted with what costs or economics and how they can be effected with minimum tearing of the remaining fabric of educational effort. (p. 313)

I suggest that our findings are informing us about what we are and are not doing in general mathematics classrooms and to what effect. Teachers reading these findings would become aware of some changes they could and should make. In short, I believe our findings hold promise for improving the practice of teaching mathematics in particular and teaching in general.

CONCLUSION

In school mathematics there are numerous phenomena that we as mathematics educators are ethically and professionally responsible for becoming "smarter about." For many of these there is no more appropriate method than observing in the natural setting of the classroom. I urge you to be responsive to this need in the field of mathematics education.

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INSTRUCTIONAL STRATEGIES FOR BASIC FACTS TEACHING

Carol Thornton, Discussion Leader
Illinois State University

The session on basic facts focused on the following major issues:

1) Whether indeed strategies for learning the "basic" arithmetic facts help students who otherwise have difficulty memorizing or retaining them?

2) What strategies are most effective for helping children master the facts?

3) What implications are to be drawn for emphasis in methods of basic fact instruction for teacher educators?

It was the consensus of those mathematics educators present that stressing strategies and relationships among facts did indeed seem to help students, especially those experiencing difficulty in mathematics. It was felt that, in early stages of memorization, approaches which focused on ways of remembering the facts were more effective than random drill alone for promoting fact mastery to retention. Personal experiences of mathematics in the classroom and clinical settings were cited, as well as the related research.

A large portion of the session was devoted to a discussion of specific strategies or techniques which appear to help students. In addition, the recent work of Larry Leutzinger in the Cedar Falls, Iowa schools was presented in support of encouraging young beginners to "count on" from the larger addend rather than counting from 1 each time. Emphasis on mastery of other "easy facts," including 10 sums and doubles, was also seen as appropriate for young beginners. The use of manipulative activities (e.g., 10-frame activities for 10 sums) and auditory and visual cues (e.g., matching clock times for the 5's facts of multiplication) were emphasized as ways of promoting mastery of fact clusters. Relating harder facts to easier facts was also supported. For example, if a child knows $5 + 5 = 10$,

then 5 + 6 is 1 more (11). Or, 12 - 6 = 6, so 13 - 6 = 7 (1 more). This "one more than" strategy, while difficult for most first graders or other developmentally immature children, appeared to be one of the most effective techniques for helping second graders or other older children master harder facts. A related technique, that of "one less" is often used with the 9's facts of addition.

What implications did the mathematics educators perceive should be drawn for teacher education? It was felt that most elementary education majors are unaware of the idea of using "strategies" or "relationships" or other cueing techniques to help students in need of memorizing the facts. It is also a fact that school mathematics textbooks do not, in general, emphasize many of the techniques which were discussed and which do appear to help children. It seemed that the consensus of the group that the definite instruction which highlights various techniques that are effective in helping children memorize the basic facts whould be included as part of mathematics methods classes. Further, whenever possible, it was felt that college students should be given the opportunity to try these techniques with children as they study them.

CLINICAL EXPERIENCES FOR PRE-SERVICE ELEMENTARY TEACHERS

Michael Kasper, Discussion Leader
Purdue University--North Central Campus

The discussion was started with the description of the clinical experiences pre-service elementary teachers have at Purdue's North Central Campus. Three years ago, they began to require students to become involved in an elementary classroom. Students are allowed to select both a school and a teacher they wish to work with for ten successive weeks. While this form of clinical experience has had many beneficial effects, there have also been some drawbacks.

Serving a four county area has involved a large amount of time and driving. The teaching times for the students in the field have also conflicted with class assignments on campus at other times. Another problem has been that some students have selected situations which are inappropriate for their needs and abilities. This has resulted in having to change some of the students' assignments during the clinical experience period.

At St. Xavier College, students are given the opportunity to work with children on a one-to-one basis. This set up in a local school has been very beneficial for both the students and the pre-service teachers.

At Michigan State University, students go out into the schools two half-days a week and are observed by a clinical professor. Before the students are placed in the schools, they must each design three units: one on geometry, one on measurement, and one on probability and statistics. Each of these units must contain six lessons. Before the student teaches the unit to a student or a group of students, the unit is evaluated on both the form of teaching and the content. Once in the school, the student is evaluated by the clinical professor on three of the six lessons.

At Illinois State University, the pre-service elementary teachers complete a four-semester sequence of professional studies courses called CORE. Each semester of the CORE experience includes four weeks of half-day pre-service clinical experiences in an elementary school in a surrounding community. The last semester of the CORE experience includes 18 weeks of student teaching, nine weeks in a variety of settings at different levels and nine weeks in a single classroom. During the third semester of CORE the students are enrolled in a mathematics methods class. During this period of time the students are placed in a mathematics or science setting for their clinical experience. The mathematics education faculty serves as clinical professors along with teacher education faculty from the areas of science and social studies education.

The University of Missouri-St. Louis now requires a two-semester hour course in clinical experiences. They send their students into a single school in a small district for ten hours of tutorial work. The teacher they are assigned to selects children from his/her class for the tutoring. The pre-service teacher then works with the child on a one-to-one basis. The response from both the school and the pre-service teachers has been quite favorable.

At the University of Northern Iowa, the students in a methods class are divided into groups of six or seven students and then each group is assigned to a classroom of 24 students. The school classroom is then divided up into small groups for each pre-service teacher to work with on mathematics.

In summary, the following ideas for clinical experiences came from the discussion:

1. The length of the experience in a school helps -- the longer the better. The longer experience helps give the pre-service teacher a feeling of continuity.

2. Transportation can cause problems. When students are scattered, it is difficult for the clinical supervisor to get to all of the schools to observe the students. If the students are clustered in a few schools in a single district, it is both easier for the students and the teacher responsible for their supervision.

3. It is important prior to the clinical experience to show the students how to create and manage learning experiences involving manipulative materials. Once they are in the classroom, they will see a great deal of teaching directly from the book. If they are to use any manipulatives, the seeds must be planted before they get to the classroom.

4. There is a need for the student to have a variety of grade level and setting experiences. This will enable the student to make a better decision on the grade level and type of grade school child they would like to work with later.

5. Lastly, the ideal situation is a combined content-methods course taught through a combination of manipulative materials and related clinical experiences.

USING THE HAND CALCULATOR IN METHODS CLASSES

Lynn Brown, Discussion Leader
Illinois State University

The session began with a description of the hand calculator-computer courses for pre-service teachers offered at Illinois State University. The course for pre-service elementary teachers covers the topics of:

1.) computer and calculator arithmetic,

2.) flow charting and BASIC,

3.) TI-[illegible] and Monroe 1880, and

4.) CAI, CMI, and computer activities.

Thecorreaponding course for teachers of junior and senior high school mathematics covers the topics of:

1.) number bases,

2.) flow chartin[illegible],

3.) subject matter topics for grades 7-12, and

4.) CAI, CMI, and computer activites.

The latter course also has a computer programming course as a prerequisite.

Following the description of the courses, classroom activities and examples were shown for each of the following goals for the use of the hand calculator in the classroom:

1.) The calculator can be used to encourage students to be inquisitive and creative as they experiment with mathematical ideas.
2.) The calculator can be used to assist in consumer related problems.
3.) The calculator can be used to reinforce the learning of the basic facts and properties for the four basic operations.
4.) The calculator can be used to develop a deeper understanding of the computational algorithms through the use of repeated operations.
5.) The calculator can be used as a flexible "answer key" to verify the results of a wide variety of computations.
6.) The calculator can serve as a resource in promoting student independence in problem solving situations.
7.) The calculator can open the door to the solution of problems which were too time consuming or impractical with paper and pencil.

8.) The calculator can be used to formulate generalizations from patterns of numbers.
9.) The calculator can be used to decrease the amount of class time spent in computational operations.

Following these examples, the participants worked on some exercises aimed at developing students' abilities in the area of estimation using the hand calculator. A geometry worksheet involving a programmable hand calculator or a micro-computer was then examined.

All of the schools represented either have or are developing courses for their pre-service majors in the use of hand calculators, micro-computers, or computers. Some already require such a course for all majors, while others only highly recommend it. Several felt that such a course should be a prerequisite for certification.

Some of the problems discussed were the lack of time in standard methods courses to adequately prepare future teachers to use the hand-held calculator in the classroom. Another difficulty mentioned was the problem of keeping current with the rapid changes in this area of educational hardware.

One of the schools represented has purchased classroom sets of a particular calculator and then they rent them to the students for $3 a term. This helps in the recovery of the costs of the calculators, while at the same time providing a common calculator type for classroom instruction.

The session ended with the sharing of resources for calculator activities for teacher education. The valuable information from the Calculator Information Center, 1200 Chambers Road, Columbus, Ohio, 43212, was especially noted.

RECRUITING SECONDARY MATHEMATICS MAJORS

Daniel Keane, Discussion Leader
Bradley University

The discussion focused on the growing shortage of secondary mathematics education majors and the factors causing the rapid decline in this population over the past ten years. Each of the schools represented has seen a dramatic drop in the number of pre-service secondary majors. However, most felt that the trend had reached its bottom point and that there might be a gradual growth in the near future.

Several possible avenues for the recruitment of potential secondary pre-service teachers were shared and discussed.

At Bradley, the effort has been on an overt selling job to mathematics majors at the freshman and sophomore levels. Special emphasis has been placed on the prerequisites for being a professional and successful teacher. The staff there has also gotten their students actively oriented toward participation in NCTM and ICTM conferences early in their collegiate careers. The impact of these efforts still shows that those that naturally select teaching still turn out to be the best students in both methods and student teaching. Similar findings were also reported from other institutions which were represented.

At the University of Minnesota, all mathematics majors receive information at the freshman and sophomore level about the course entitled Introduction to Secondary Teaching given by the mathematics education staff. The material stresses that secondary teaching offers the opportunities to work both with people and with mathematics. This combination of requirements and opportunities is heavily stressed from the working with people viewpoint. The staff there feels that this approach has been moderately successful. However, they still have shortages at the 7-8 level.

At Illinois State University the department has sponsored secondary school mathematics contests and offered free career talks about mathematics to high schools in the state. Both of these activities have involved both the recruitment of good students and the spreading of the word about the shortage of qualified secondary mathematics teachers. There seems to have been some slight success in attracting good students. The department has also encouraged good undergraduates through positions as tutors and undergraduate teaching assistantships for remedial algebra classes at ISU.

One other suggestion involved the participation of the state level mathematics teacher organizations in the alerting of the mathematics, mathematics education, and public school authorities about the seriousness of the situation. It was felt that the situation might be helped by a series of articulation conferences explaining the problem to high school counselors, high school teachers, and mathematics teachers at the undergraduate level. Such a team effort focused on the problem might slightly help to improve the present situation.

TEACHING ALGORITHMIC PROCESSES IN ELEMENTARY METHODS

Ed Rathmell, Discussion Leader
University of Northern Iowa

The discussion leader began the session by presenting to the group a sheet stating his opinion on the following four questions:

1. How does a typical commercial textbook treat the development of algorithm learning?
2. How does a typical elementary teacher treat the development of algorithmic learning?
3. What is the role of models in the learning of algorithmic processes?
4. What can we do in methods classes to make our students more effective in teaching algorithmic processes?

A discussion of points in the paper followed. It started with a discussion of the need for a textbook. It was decided that a textbook gives a sequential development and enables everyone to look at the same thing at the same time. In addition, it provides practice excerises and suggestions for teachers.

A question was raised; is it important to manipulate models? One opinion is that it is good to demonstrate rather than actually manipulate depending on the quality of teaching. Other questions raised during this discussion were: should method students use manipulatives or just texts? Do we demonstrate to them or let them do it themselves? Do we direct their activities or let them evolve? Again, the quality of teaching was the answer; i.e. good teaching can and probably does use any or all of these methods.

One of the problems that educators have is being able to check to see if the students have the correct vocabulary and understand the vocabulary necessary to teach these algorithmic processes. Are the

students able to explain the math concepts in real world vocabulary as well as math vocabulary? One way suggested to test the students is by giving them a model or diagram and asking them to explain it mathematically and in words as part of their evaluation.

Another issue raised was why do children understand addition and subtraction algorithms better than multiplication and division? The reason is probably because of mental imagery. More manipulatives are used for the former operations than for the latter pair, so the child has better mental images for addition and subtraction. One point brought out in this discussion was the importance of matching the model to the algorithm so that a good mental image can be developed.

Another question dealt with how can we change the teacher's style? Do teachers teach the way they've been taught? One way is to provide some of the development of the algorithms through manipulatives - textbooks cannot provide it all. We should educate them to emphasize and show, rather than emphasize and tell. It is important for us to lead pre-service teachers to discover the power of manipulatives.

All in all, it was decided that a multiplicity of approaches is necessary. There is a need for manipulatives, whether actually manipulated or demonstrated, to reinforce the textbooks' presentation of algorithms. The quality of teaching affects how much the student learns and how the manipulatives are used.

TESTING MATHEMATICAL COMPETENCIES OF ELEMENTARY TEACHERS

Norman Young, Discussion Leader
Concordia Teachers College

The discussion began with the consideration of the MATHCOMP program at Concordia. This program involves testing all in-coming students with below average ACT math scores. This testing centers on the areas of basic skills normally taught in grades 7 - 9. Following the outcome of the tests, appropriate plans of remediation are laid out for students needing special help.

Other schools use different testing and teaching programs to address the question of basic skills for elementary teachers. Illinois State University tests elementary majors as part of the content course for elementary teachers.

The difficulty of evaluating pre-service teachers' instructional competencies was then discussed. Bowling Green State University has a tutorial program for local children. In it, local children are given diagnostic tests and then tutored by pre-service methods students. Bradley University uses field experiences combined with video-taped micro-teaching experiences.

The questions of the testing of problem-solving ability and the ability to use mathematical language were discussed. The group was not able to reach common agreement on these questions.

The session ended with a consideration of the proposed revised NCTM "Guidelines for the Preparation of Teachers of Mathematics." Most felt that these guidelines were "pie-in-the-sky." None of the programs represented at the session felt their programs could meet the upper elementary or middle school objectives.

SIMULATIONS AND THEIR ROLE IN SECONDARY METHODS

Peggy House, Discussion Leader
University of Minnesota

Dr. House presented some examples of the use of simulation via video-tape as they are used at Minnesota. She began by describing how the use of such programs spanned several gaps present in observation oriented programs. In particular, the events of the classroom are spontaneous, leave no record, and appear different to different observers.

Each of these problems can be corrected by the use of video-taped sequences from the mathematics classroom. At Minnesota, video-tapes of portions of mathematics classes, each involving 12 - 14 students have been made on:

1. Problem Solving Styles,
2. Heuristic Approaches,
3. Designing Problem Solutions,
4. Developing Concepts, and
5. Inquiry Lessons.

Through the use of the tapes, the faculty attempt to both teach heuristics and at the same time teach teachers to use those heuristics. In addition, they give both pre-service and in-service teachers a chance to observe other teachers and teaching styles in action. Also, the teachers' observational skills increase.

Class discussions can focus on concept strategies, inter-personal relations, managerial aspects, or environmental influences. In addition, the tapes allow the class to watch an episode, discuss it, and then

review it. In using the tapes she felt that one of the best strategies was to first carefully work through the mathematics discussed in the tape with the teachers viewing the tape. Following this, salient points to watch for were mentioned, followed by a viewing of the tape.

Experiences with students at Minnesota have been quite positive to date. They seem to have developed greater flexibility in teaching and better observational skills. Further information on the tapes and their availability is available from:

Dr. Peggy House
330 Peik Hall
159 Pillsbury Drive S.E.
University of Minnesota
Minneapolis, Minnesota 55455

USING TEXTBOOKS AND OTHER INSTRUCTIONAL AIDS IN THE ELEMENTARY METHODS COURSE

Glenn Nelson, Discussion Leader
University of Northern Iowa

The discussion began with the agreement that pre-service teachers should be expected to be curriculum users and implementors, rather than curriculum developers.

Several uses for elementary text series in the methods course were then discussed. Among them were:

1. What topics are taught in elementary school?
2. At a given grade level, what topics are given the most attention?
3. For a given text series and topic, which units are considered introductory units, mastery units, or maintenance units?
4. For a given grade level and topic, which of two series gives a better treatment? Why?
5. For a given grade level, text series, and topic, what is the purpose of each lesson in a unit? (review, development, practice, enrichment,...)
6. After selecting a certain topic, what needs to be covered? (review, practice, development, application, evaluation,...)
7. For a given student, how does the text need supplementing?
8. For a given lesson, write a lesson plan with a) extending activities, b) review activities, or c) remedial activities.

Each of these questions was discussed and specific examples cited. Several participants noted the need for the development of "scope and sequence" charts both for a text series and for the elementary curriculum. Marilyn Jacobson noted that students need grade level summaries of the curriculum in addition to the scope and sequence work.

Other materials suggested as important items for the methods course were:

1. manipulative aids,
2. practice activities and games,
3. activity source books and companies,
4. standardized tests,
5. movies, video-tapes, etc., and
6. sources of "real world" applications, etc. for activity file folders.

ESTABLISHING AND MANAGING A MATHEMATICS CLINIC

Edna Bazik, Discussion Leader
Illinois State University

The session began with an analysis of the Mathematics Clinic concept and the current status of clinics around the country (See Figure 1). An analysis of the findings shows a wide diversity in the scope and missions of the various programs. Following additional comments, three specific programs were analyzed in some detail.

The Remedial Math Clinic at Illinois State University has been in operation since 1976. It was originally developed to aid in the pre-service education of special education majors. However, it now serves as a basis for that original course plus 3 diagnosis and remediation courses for undergraduates and graduates. In the past year it has been expanded to include work with secondary and university level students.

For students in grades 1 - 9, the initial contact with students and parents is made through the schools and through notices placed in the local newspapers. The respondents are given an application blank to complete and are then placed on a waiting list. Once the registration process is complete and the number of students enrolled in the clinic course is known, parents with children on the waiting list are contacted on a first come - first served basis.

The information gathered from parents includes permission to discuss the child's progress with the child's teacher, the text and level the child is currently enrolled in, and the parents and/or school's diagnosis of the apparent difficulty. Upon entering the Clinic, the child is given the KeyMath by one of the students in the Diagnosis and Remediation class. The results of the child's performance is then shared with the student(s) who will be working with the child. They

UNIVERSITY BASED MATHEMATICS CLINICS

	Course Level	# Courses	Sem. Offered F, Sp, Su M-Multiple	Purpose T-Clinician Training S-Student R-Research	Focus D-Diagnosis I-Instruction	Client Age Group Served E-Elem. Sch. M-Math Defic. H-High Sch. U-University	Client Problems G-Gifted M-Math Deficiency H-Special Handicap L-Language	Fee Charged Clients	Initial Year	# Contact Hours
Arizona State	G	3	M	T-S-R	D-I	E-M	M	$35	1974	20
Bowling Green State Univ.	U-G	3	M	T-S-R	D-I	E-M-H	M-G	$ 5	1972	14
Edinboro State College	G	2	M	T-S	D-I	E-M	M-G	$35	1976	15
Florida Tech. Univ.	G	3	M	T-S	D-I	E-M-H	M	YES	1972	20
Illinois State Univ.	U-G	5	M	T-S-R	D-I	E-M-H-U	M-H	$ 2	1976	20+
Indiana Univ. S. Bend	G	1	M	T-S	D-I	E-M-H-U	M-H	YES	1977	14
Indiana Univ. of Pennsyl.	G	1	F-Sp	T-S	D-I	E-M-H	M-H	YES	1977	12
Kean Coll. of New Jersey	G	1	M	T-S-R	D-I	E-M	M-G	$10	1979	15
Kelvin Grove Coll. (Australia)	U-G	3	M	T-S-R	D-I	E-M	M	NO	1976	20
Kent State Univ.	G	4	M	T-S-R	D-I	E-M-H	M	NO	1972	20
Mansfield State Coll.	U-G	2	M	T-S	D-I	E	M	NO	1977	10
Northern Arizona Univ.	G	1	M	T-S	D-I	E-M	M		1979	
Queens Univ. (Canada)	G	U	M	T-S	D-I	E-M	M		1979	
San Diego State Univ.	G	1-R	M	T-S	D-I	E-M	M-L	NO	1975	16
Seattle Univ.	G	1	Su	T-S	D-I	E-M	M	NO	1978	13
Southern Illinois Univ.	U-G	4	M	T-S-R	D-I	E-M-H	M	YES	1978	48
Stephen F. Austin State Univ.	G	2	Su	T-S	D-I	E-M	M-G	YES	1975	20
Univ. of Connecticut	G	3-R	M	T-S-R	D-I	E-M-H	M	NO	1969	
Univ. of Arizona	G	1	S	T-S	D-I	E-M	M	NO	1979	20
Univ. of Houston	G	3	M	T-S-R	D-I	E-M-H	M-H	YES	1978	15
Univ. of Maryland	U-G	4	M	T-S-R	D-I	E-M-H	M-H-G	YES	1971	20
Univ. of South Florida	U-G	3	M	T-S-R	D-I	E-M	M	YES	1971	14
Wayne State Univ.	G	1	M	T-S	D-I	E-M-H	M	YES	1964	20
West Virginia Univ.	G	1	F-Sp	T-S	D-I	E-M	M	NO	1973	10
Western Maryland Coll.	G	1	M	T-S	D-I	E-M	M-G	YES	1976	24

Figure 1

then develop, with the teacher's aid, a plan for strengthening the child's skills and conceptual understanding.

Prior to each lesson with the child, they develop a lesson plan for the period. This plan as well as any modifications, is then written up for the student's log. At the end of the semester each college student submits his/her report on the progress of the child they tutored. Specific attention is given to progress toward the long range goals stated at the beginning of the period.

At Bowling Green State University, the Mathematics Clinic serves both elementary and secondary students in the areas of skill development for low-ability students, enrichment work for high-ability students, and special assistance for students with a specific difficulty.

University students from an elementary methods clinic course, as well as students from a secondary methods course and an advanced elementary methods course staff the clinic under the supervision of faculty. The enrollment in the clinic averages 175 students per quarter. The elementary clinic meets 1 day per week for seven weeks for 75 minutes per session. The secondary clinic meets 2 days per week for seven weeks for 60 minutes per session.

At Southern Illinois University at Carbondale, the Diagnostic Math Clinic is designed to provide help to children experiencing learning problems in mathematics while at the same time helping in the preparation of teachers. Data is collected from the school's records, from an informal assessment of classroom activities, and from an information battery completed by parents. This data is combined with testing data when the child enters the Clinic. Following the work in the Clinic a report is sent to the person indicated by the parents.

Additional time was spent in discussing the needs for space, transportation arrangements, and coordinating student clinicians in the various clinics.

ARRANGING AND MONITORING CLINICAL EXPERIENCES FOR PRE-SERVICE SECONDARY TEACHERS

Max Gerling, Discussion Leader
Eastern Illinois University

The session began with a discussion of the clinical experiences component for secondary teachers at Eastern Illinois University. The clinical experiences at EIU are monitored by a special clinical experiences office. Each student applying for teacher education must present 20 hours of prescribed clinical activities for admission. In addition, the educational psychology course provides the student with 10 clock hours of experience plus 5 periods of laboratory work. In the special methods in mathematics class, the pre-service teacher gets an additional 10 clock hours of clinical experiences plus 20 periods of laboratory work.

The remaining hours of clinical work are accomplished through the completion of a series of activities outlined in a module used in the first portion of the student teaching experience. These activities cover acquainting the student with the school, the available materials, the students, the faculty, and the rules and regulations.

Lynn Brown then described the format for pre-service teaching clinical experiences at Illinois State University. ISU requires 100 hours of clinical experiences prior to student teaching. The pre-service secondary major gets 55 hours of these in the general secondary methods classes taught in the College of Education. An additional 10 hours are acquired in the completion of an educational psychology course.

The remaining 35 hours of clinical work is completed as part of the requirements of the secondary mathematics methods class given by the Department of Mathematics. These activities are usually carried out at University High School or one of the local high schools where student teachers are placed.

DIAGNOSTIC AND PRESCRIPTIVE MATHEMATICS FOR SECONDARY MAJORS: PRE-SERVICE AND INSERVICE

Lotus Hershberger, Discussion Leader
Illinois State University

The goals for the session were to share information on what was being done in diagnosis and remediation for secondary majors, both pre-service and inservice, and to engage in a general discussion about diagnosis and remediation in relation to a secondary mathematics education program.

Lotus Hershberger described some courses and other activities at Illinois State University, including a course for inservice teachers entitled Diagnosis and Remediation in Secondary School Mathematics, a mathematics education module which is part of the Doctor of Arts program in mathematics, and several activities which take place in the I.S.U. Mathematics Center. Persons from the other six colleges and universities represented described some of what is happening on their campuses. Most reported tutoring opportunities for their secondary majors, but few reported that this is a required part of their secondary programs. Some described clinic type activities, but most of these took place at the elementary level rather than the secondary level. Most have no formal coursework or activities in diagnosis and remediation for secondary level majors, pre-service or inservice.

The discussion centered about the following items:

1) Most schools have some kind of a tutoring program. These programs offer the opportunity to improve our secondary major programs by getting our students involved and by our supporting instruction and discussions. Opportunities for tutoring, analyzing tutoring, diagnosing difficulties, and providing helpful remediation should be used to enrich our secondary mathematics education programs.
2) All agreed that some experience in diagnosis and remediation is appropriate for secondary majors. There was disagreement on whether it should be required or only be an option. The basis for this disagreement was the fullness of the secondary program and what would have to be given up for the added work in diagnosis and remediation.

STRUCTURING METHODS CLASSES TO MEET A WIDE VARIETY OF STUDENT NEEDS AND BACKGROUNDS

Ken Retzer, Discussion Leader
Illinois State University

To stimulate discussion of providing for individual differences in our methods course, Ken Retzer distinguished between providing for differences in our methods teachers in the classes and helping the pre-service teachers prepare to provide for differences among their eventual students.

Pre-service teachers form a reasonably homogeneous group - mathematics majors with similar experiences in the College of Education and in the schools. The greatest challenge at Illinois State is in trying to select topics to be covered in a 3 semester hour course which seem most crucial before graduation because appropriate topics could easily generate 10 hours credit. Pre-service teachers have input into choosing those topics and can work independently on those topics not selected for the class at large. Such a topic list was displayed to stimulate discussion.

With respect to helping them provide for individual differences among their students, use of guest lecturers who had a variety of physical limitations ranging from hearing & seeing limitations to Cerebral Palsy were cited. Readings describing the interface of mathematics with ability levels (e.g. slow learners & gifted) and minorities (e.g. American Indians & Chicanos) were made available in a circulating memo format.

In the discussion which followed similar provisions at other universities were described. Attention was called to the results to date of research into the effectiveness of different teaching strat-

egies for different ability groups. Reference was made to NCATE standards for multicultural education and participants generally agreed that mathematics itself was a cross cultural subject and differences in teaching it may stem only from such things as cultural effects on competitiveness and desire to excel.

THE ROLE OF LABORATORY EXPERIENCES IN PRE-SERVICE METHODS CLASSES

John Dossey, Discussion Leader
Illinois State University

The discussion group considered the following questions concerning the role of laboratory experiences:

1) What materials should be used, how long, and in what sequence?

2) Should the materials be used by students or only explained by instructors?

3) What levels of competence should be expected?

4) Should the focus be on homemade materials or commercial materials?

5) How should work with materials be evaluated?

6) Should students be expected to create new materials and games?

7) How much time should be spent on the administrative and management aspects of using materials in a classroom?

At Illinois State University, pre-service elementary teachers have hands-on experiences with attribute materials, Cuisenaire Rods, Dienes Multibase Blocks, metric materials, and geoboards. In several of the course sections, the students are given a performance test over the use of the attribute materials, multibase blocks, Cuisenaire Rods, and geoboards.

These materials are used both in the basic content course for elementary teachers as well as in the methods courses. Several of the advanced methods courses focus time on the creation and construction of appropriate manipulative materials. Other course activities involve the pre-service teachers in the development of lesson plans incorporating the use of such materials in specific lessons, the design and field-testing of activity cards, and the evaluation of materials for classroom use. Other time is spent in helping pre-service teachers

consider the classroom management skills necessary for the use of manipulatives in the classroom. Work is also done with helping the students develop modes of recording the findings of their investigations.

At the University of Northern Iowa, the program also introduces manipulatives along with the content course. The staff at UNI has pulled together materials from text series and developed a parallel sequence of laboratory activities. Emphasis is placed on the transitions from model to sketch to verbal to symbolic forms. Time is spent in class drawing closure to the sequence of models used in the completion of a given algorithm in the development of a specific concept.

Dr. Peggy House of the University of Minnesota reported that in classes for pre-service secondary teachers she has them take a model (such as model for $(a + b)^3$) and list all situations where it can be used. Then she has students select a topic and list all models which might be used in teaching that topic.

The discussion group felt the payoff through the use of materials is sometimes slow in coming and thus many teachers give up early. They need support in the beginning from supervisors and administrators. This should be possible through the development of in-service education for these groups and the careful integration of the materials used in the curriculum.

IN-SERVICE MATHEMATICS EDUCATION PROGRAMS

James Lockwood, Discussion Leader
Northeastern Illinois University

Jim Lockwood offered as a premise for this discussion that in-service education program should have as their aim the enduring change of the behavior of the participants.

Opportunities offered by Northeastern include an advanced methods class and workshops in geometry, measurement, and the nature of math ability in school children. They do not offer a masters degree as does I.S.U. (the only other school represented in the group).

All present who have had experience with in-service education expressed concern about the value of in-service education in terms of actual change of behavoir. Jim stated five conditions necessary for change of behavior:

1) desire to improve,
2) knowledge of personal weaknesses,
3) must work in a permissive climate,
4) must have a helper who is interested and skilled,
5) must have the opportunity to try new ideas.

Each of the items was discussed in length using our various perceptions of contemporary secondary schools. Fred Fleenor explained the seemingly successful teacher center method of in-service education used in England.

The following suggestions for possible improvement of in-service programs were offered:

1) Arrange for follow-up visits to the schools of the participants both during and after the courses in which they are enrolled.

2) Require students taking a weekly class to make and/or use something new and report back the following week as to its success/failure along with suggestions for improvement.

3) Establish a rapport with the cooperating teachers of our pre-service teachers. Later we can possibly serve those teachers and/or schools.

4) Establish an attitude of need for continued growth in our pre-service teachers so that they will be more desirous of and open to in-service education.

DIAGNOSTIC AND PRESCRIPTIVE MATHEMATICS FOR PRE-SERVICE AND IN-SERVICE ELEMENTARY TEACHERS

Janet Scheer, Discussion Leader
Southern Illinois University-Carbondale

The discussion covered the courses offered at Southern Illinois University in the areas of diagnosis and remediation in elementary mathematics. The program consists of two courses, a practicum, and an internship. The focus of the four course sequence is on:

1) examining techniques useful for identifying children's strengths and weaknesses in mathematics,

2) developing specific strategies for instruction to correct the identified, and

3) applying these techniques and strategies on a one-to-one basis with children having difficulty in mathematics.

The four courses are CIM 407E - Disgnosis and Corrective Techniques for the Classroom Teacher (3 credits), CIM 515 - Advanced Remediation in Mathematics (3 credits), CIM 594E - Practicum (3-6 credits), and CIM 595E - Internship (3-6 credits).

The first course, CIM 407E, focuses on models of procedures for, and outcomes from diagnosis. Specific attention is given to norm-referenced and criterion-referenced tests that are used in mathematical diagnosis. The KeyMath Diagnostic Arithmetic Test is examined in detail. Additional time is spent looking at common trouble spots in the elementary curriculum. Consideration is given to other sources of information about a child's mathematical and information processing abilities.

In the Advanced Remediation in Mathematics course, CIM 515, a solid base is built for the remediation of specific mathematical learning problems at the elementary school level. The focus is on diagnostic teaching with an emphasis on careful sequencing of instruction. Building

on basic concepts and readiness activities, the students develop and present teaching sequences for the basic operations from the whole numbers through fractions and decimals. These two courses are followed by the Practicum (CIM 594E) and Internship (CIM 595E) experiences during which they work with children and then with pre-service elementary teachers in the Diagnostic Math Clinic at SIU-C.

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